

[0047] FIGS. 19A to 19D are diagrammatical views showing the operation performed by the tactile device of FIG. 18A to transmit tactile information via the accelerator pedal and the vehicle floor to the driver when the accelerator pedal is depressed to accelerate the vehicle;

[0048] FIGS. 20A to 20D are diagrammatical view illustrative of the operation performed by the tactile device of FIG. 18A to transmit tactile information via the accelerator pedal and the vehicle floor to the driver when the pressure on the accelerator pedal is released to slow down the vehicle;

[0049] FIG. 21 is a perspective view with parts cut away for clarity of a driver's seat in which a tactile device according to still another embodiment of the invention is incorporated;

[0050] FIGS. 23A and 23B are diagrammatical views showing an operational relationship established between the tactile sensor assembled with the accelerator pedal and the vehicle floor and the tactile device incorporated in a seat cushion of the driver's seat when the accelerator pedal is depressed;

[0051] FIGS. 23A to 23C are diagrammatical views illustrative of the operation of the in-seat tactile device performed when the accelerator pedal is depressed;

[0052] FIG. 24A is a fragmentary plan view of a part of the steering wheel in which a tactile device according to another embodiment of the invention is assembled;

[0053] FIG. 24B is a cross-sectional view taken along the line 24B-24B of FIG. 24A;

[0054] FIG. 25A is a view diagrammatically illustrating a tactile device for comparative purposes with the tactile device shown in FIGS. 24A and 24B;

[0055] FIG. 25B is a view similar to FIG. 25A but showing the tactile device according to the embodiment shown in FIG. 24A;

[0056] FIG. 26 is a diagrammatical view of a tactile device according to a modification of the present invention;

[0057] FIG. 27A is a perspective view showing the general configuration of a vehicle state information transmission apparatus according to another preferred embodiment of the present invention;

[0058] FIG. 27B is a view in a direction of the arrow 27B shown in FIG. 27A;

[0059] FIG. 28 is a flowchart showing a series of operations to be achieved by an electronic control unit (ECU) of the apparatus shown in FIG. 27A so as to alter conditions for a tactile vehicle state information transmitting operation and simulate the tactile vehicle state information transmitting operation based on the altered conditions while the vehicle is in a stopped or parked state;

[0060] FIG. 29A is a side view showing a tactile device assembled with an accelerator pedal according to another embodiment of the present invention;

[0061] FIG. 29B is a perspective view of the accelerator pedal and the tactile device assembled therewith;

[0062] FIG. 30 is a block diagram showing a conventional vehicle state information transmission apparatus according to;

[0063] FIG. 31 is a cross-sectional view of a conventional vehicle steering wheel having a rubber tube fitted around a periphery of the steering wheel as a tactile device; and

[0064] FIGS. 32A to 32D are views diagrammatically illustrating operation of a conventional tactile device incorporated in a vehicle steering wheel.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0065] Referring now to the drawings and FIG. 1 is particular, there is shown a vehicle state information transmission apparatus 11 installed in a vehicle 12 for transmitting vehicle state information to a human driver. The term "vehicle state" is used herein to generally refer to traveling states or behaviors of the vehicle and conditions of various parts of the vehicle as on-vehicle devices.

[0066] As shown in FIG. 1, the vehicle 12 includes a body 13, a passenger compartment 14 defined in the body 13, a driver's seat 15 disposed inside the passenger compartment 14, a dashboard 16 disposed in front of the driver's seat 15, a power steering apparatus 17, a brake pedal 21, an accelerator pedal 2 serving as an operating means actuatable by the driver for operating the vehicle 12, a parking brake lever 23 provided on a left side of the driver's seat 15, an electronic control unit (ECU) 24 for controlling the vehicle 12, a vehicle state detection device 25 for detecting various states or conditions of the vehicle 12, a driver identification device 52, a navigation device 26 mounted in the dashboard 16, an instrument panel 27, a travel direction detection device or sensor 70 associated with a shift lever (not designated) for detecting a travel direction of the vehicle 12, and the aforesaid vehicle state information transmitting apparatus 11. The travel direction sensor 70 also forms part of the vehicle state detection device 25.

[0067] The power steering apparatus 17 includes a steering wheel 31 serving as an operation means actuatable by the driver for operating the vehicle 12, a steering shaft 32 connected at one end to a central hub of the steering wheel 31, a steering angle sensor 33 disposed adjacent to the steering shaft 32 for detecting a steering angle of the steering wheel 32. The steering wheel 31 has a body 34. The steering angle sensor 33 also forms part of the vehicle state detection device 25.

[0068] More specifically, the vehicle state information transmission apparatus 11 generally comprises the vehicle state detection device 25, a warning indicator (warning means) 38 operable based on information pertaining to the vehicle states detected by the vehicle state detection device 25, a mobile phone connector (not shown) for connection with a mobile phone, and a vehicle state information transmitting means or device 41.

[0069] The vehicle state information transmitting device 41 includes a tactile means or device 42 assembled in the steering wheel 31 and operable based on information pertained to the vehicle state detected by the vehicle state information detection device 25 to transmit the vehicle state information via the steering wheel 31 to the driver as tactile information, a tactile ON/OFF switch 43 for selectively enabling and disabling the tactile device 42, a warning selector switch 44 for selecting various warnings to be transmitted via the tactile device 42, a tactile pattern input section 45 for selecting tactile patterns for the tactile device 42, an amplitude selection switch 47 for selecting the amplitude of the tactile pattern (operation pattern) of the tactile device 42, and a driver circuit 46 for driving the tactile device 42 based on information received from the ECU 24.

[0070] In the illustrated embodiment, the tactile device 42 consists of a left tactile device 51 and a right tactile device 53.